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Research paper

Efficiency of integration crashing program and building information modeling on high rise building projects

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Abstract

This study is to analyze the Efficiency of Integration of Crashing Program and Building Information Modeling in the High Rise Building Project. The method of sampling is done by using the Purposive Sampling method there are 60 people in total. From the sampling technique used in the research then the sample criteria used as primary data sources in this study are Project Manager, Site Manager, Engineering Head, Site Engineer, and Drafter. This study uses SEM analysis to assess the Integration Efficiency of Crashing Program and Building Information Modeling on Project performance (Time and Cost). The results of the Analysis of Integration of Crashing Program and BIM in the High Rise Building Project, Crashing Program and Building Information Modeling have an effect on Time and Cost Performance. Crashing Program (CP) provides efficiency on time performance and cost performance by 52%. Building Information Modeling (BIM) provides efficiency for time performance and cost performance by 50%. Integration of Crashing Program (CP) and Building Information Modeling (BIM) provides efficiency for the implementation of the High Rise Building project by 25%.

Keywords: *Use about five key words or phrases in alphabetical order, Separated by Semicolon*

1. Literature review

1.1. Integration

Integration is an attempt to combine two or more methods into one. The Big Indonesian Dictionary defines integration as blending to become unity. The word unity implies a variety of different elements from each other experiencing the process of blending. If renewal has reached a meeting, then the symptom of this change is called integration.

1.2. High-rise buildings (high rise building)

Tall buildings range from less than 10 floors to 100 floors (Schueller, 1977). Reiterated by Neufert (1995), buildings with a height of 3 to 5 floors are called medium rise buildings. In addition, Mulyono (2010), buildings that can be categorized as high rise buildings are buildings that have a number of floors 6 floors up or with a minimum height of> 20 meters (Mulyono, 2010).
According to Law Number 28 Year 2002 Chapter III Article 5 which identifies the functions of building as follows:

a) Residential function: apartment, apartment, hotel
b) Religious functions: churches, temples, mosques
c) Business functions: offices, malls, warehouses, tourist attractions
d) Social and cultural functions: school, hospital

1.3. Project objectives

According to Suharto (2001), each project has a specific goal in which there are limits that must be met, namely the allocated project budget, the project implementation schedule, and the quality that must be met. These three things are often associated as project goals as Cost, Quality and Time. Project management is said to be good if the target is achieved.

a) Cost-effective

Projects must be done at a cost that does not exceed the budget, both the cost of each work item, the cost of each implementation period, and the total cost until the end of the project.

b) Exact quality

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The construction project product that is carried out by a construction service company is the project as a whole including the system / process and its physical parts. Product quality, or can be called performance performance, must meet specifications and criteria at the level required by the project owner / owner.

c) On time

Projects must be done with time in accordance with the planned schedule of projects / schedules that are shown in the form of work progress. The time of project implementation should not be late either per implementation period, or the time of handover of the project

1.4. Time performance

According to Halpin, et al (2017), a project manager controls various types of activities at the project location, one of the important aspects that is monitored is time performance. Time performance is the process of comparing work in the field to the planned schedule.

Duration (duration) can be defined as the time needed to complete or complete an activity or task that has been set. The time of project implementation is the time determined by the owner to use, use or lease the building of the project (Callahan et al, 1992).

From the explanation above, the criteria for implementation time according to Sri (2001), are divided into 3 conditions, namely:

a) Slow Duration

Slow duration is the duration which for some reason and other things has a duration that is slower than the normal duration

b) Normal Duration

The normal duration is the project implementation time which utilizes the greatest effective and efficient capacity of the workforce who work normally, namely 7 hours a day and 1 hour rest (in accordance with the Labor Law in Indonesia)

c) Fast duration

Fast duration is the time of project implementation which utilizes the maximum capacity of the workforce plus overtime or rotation.

In carrying out a project there are factors that influence the timing of construction. According to James (2007), these factors include:

a) Project Size

Project size can be viewed functionally or in area in ft^2 or m^2. The larger the size of the building, the more the construction complex and requires a longer completion time.

b) Building Functions

The function of a building implies the business targets to be achieved, for example office, retail and other buildings.

c) Complexity

Complexity describes the complexity of work. The complexity of buildings has an impact on construction methods such as the type of foundation used or other constructions.

d) Quality

Quality can be classified by variables or attributes, namely the appearance of strength, stability and use of material. The appearance of a building is one aspect of quality assessment.

e) Location

The location of the building has an important impact on the time of project implementation, because the project location has an impact on the availability of resources such as materials, tools and people.

1.5. Cost performance

The important thing about project implementation is the time quality cost or commonly referred to as the abbreviation "BMW". Cost is an important factor in planning a project. Costs that arise in a project are:

a. Direct costs are costs that arise and are directly related to ongoing project activities including material or material costs, wage costs, equipment costs

b. Indirect Costs are costs required for each project activity, but are not directly related to the activities concerned and are directly related to the activities in question and are calculated at the beginning of the project until the end of the project, including Overhead costs, unexpected costs, profits.

1.6. Crashing

The process of accelerating the project time is often also called "crashing". The term crashing refers to a reduction in the duration of a particular activity that has an impact on reducing the overall duration of the project. According to Callahan (1992), the crashing process is a process that is carried out intentionally, systematically analytically that takes into account all the activities that are in the project and focuses on activities that are in the critical path.

The crashing process uses a minimum variable cost assessment to shorten the overall duration of the project. Although the crashing process seems very simple in concept, the reality is very complex. There are many ways to reduce the duration of activities, and many time and cost combinations of activities must be considered as a complete analysis. Crashing is closely related to time and cost, following a graph of the relationship of costs and time. Crashing is used at the beginning of the project to the end, but using it at certain times, here is when crashing is used (Berniz, 2017):

a) Project late
b) Prevent future delays
c) The project team will work on another project
d) Availability of resources
e) Trained resource
f) Bonus time

The use of crashing also has several stages, along with the steps:

a) Critical path analysis
b) Identify tasks that can be shortened with additional resources
c) Calculation for each task for time reduction
d) Choose the cheapest approach

e) Provides a crashing budget and the project baseline is submitted to the owner

Crashing also has advantages and disadvantages. According to Rachman (2013), the advantages and disadvantages are as follows:

a) Excess crashes
1) Can reduce the duration of work
2) Can minimize work costs.
b) Lack of crashing
1) Can not analyze the quality of work
2) Can risk the accumulation of workers if not done carefully.

According to Rachman (2013) there are two components of time and cost, namely:

a) Time component
1) Normal Time, which is the completion of activities under normal conditions.
2) Time of acceleration (Crash Time), which is the shortest time possible to complete an activity

From the two components of time, the acceleration time is obtained, with the equation:
Total Acceleration Time:

Normal Time - Acceleration Time (1.1)

b) Cost component
1) Normal costs, which are direct costs to settle in normal conditions.
2) Acceleration (Crash Cost) costs, namely direct costs for completing activities in acceleration / crash conditions in the shortest possible conditions for completing activities).

Total Acceleration Cost:

Acceleration Costs - Normal Costs (1.2)

3) Acceleration per unit (slope) costs, ie direct costs for completing activities in acceleration / crash conditions (in the shortest possible conditions for completing activities) in the smallest unit of time determined using equations:

Acceleration Cost per Unit of Time (Slope):

$$\frac{Total\ Cost\ Acceleration}{Total\ Time\ Acceleration} \quad (1.3)$$

1.7. BIM (building information modeling)

BIM is basically a digital platform for making virtual buildings. If BIM is applied, the model must be able to contain all the building information, the information is used to collaborate, predict, and make decisions about the design, construction, cost, and maintenance phase of the building

Building Information Modeling (BIM) is an approach to building design, construction and management. The scope of BIM supports project design, schedules, and other information in a well-coordinated manner.

BIM can change the way AEC (architecture, engineering and construction) works together to communicate, solve problems and build projects better faster and at less cost.

The advantages of BIM services according to Biemo (2014) are as follows:

a) Minimize lifecycle design by increasing collaboration between owners, consultants and contractors
b) High quality and accuracy of documentation from the construction process
c) BIM technology is used for the entire life cycle of buildings, including operation and maintenance facilities
d) High quality products and minimize the possibility of conflict
e) Cutting project costs and minimizing construction material waste
f) Improve construction management

2. Research methods

1) Sampling Techniques

The sampling method used is using the Purposive Sampling method (Umar, 2013), which is the selection of samples based on certain characteristics that are considered to have relevance to the characteristics of the population that have been previously known.

2) Reliability and Validity of Instruments

Reliability shows consistency and stability of a score (scale of measurement). Reliability differs from validity because the first focuses on consistency problems, while the second focuses on the issue of accuracy.

3) Structure of Equation Modeling (SEM)

Structure Equation Modeling (SEM), is the most common statistical modeling technique, and has been used extensively in behavioural science. SEM can be shown as a combination of factor analysis, regression analysis, and path analysis.

3. Results and discussion

1) Test Validity and Reliability

For testing validity, the minimum loading factor is 0.5. Indicators that have a factor loading below the minimum limit will be excluded from the measurement model, but because no factor loading is found with a value below 0.5, all indicators are included in the model and the measurement model is considered valid.

For reliability testing, from the factor loading value in the previous test, construct reliability calculations were made, that the value of this construct reliability minimum is 0.7. The results of the calculation show that all variables have a value of construct reliability above 0.7 so it can be concluded that the measurement model is considered reliable.

Table 1 below shows the factor loading value along with the construct reliability value of the reliability test.

Table 1: Factor Loading Dan Construct Reliability

Variabel		Factor Loading	Construct Reliability
CP - Crashing Program			0,859
-	CP1	0,789	
-	CP2	0,833	
-	CP3	0,706	
-	CP4	0,712	
-	CP5	0,659	
BIM - Building Information Modelling			0,835
-	BIM1	0,613	
-	BIM2	0,645	
-	BIM3	0,787	
-	BIM4	0,820	
-	BIM5	0,668	
KW - Time Performance			0,904
-	KW1	0,846	
-	KW2	0,815	
-	KW3	0,852	
-	KW4	0,761	
-	KW5	0,766	
KB - Cost performance			0,853
-	KB1	0,647	
-	KB2	0,809	
-	KB3	0,780	
-	KB4	0,792	
-	KB5	0,627	

2) Conformity Test

This theory-based model testing is done using AMOS version 21 software.

The results of the conformity test show that the probability value (p) = 0.133. These results indicate that H_1 is accepted, which means the model proposed in the study is considered to represent the characteristics or behaviour of the population or also called the model is declared fit, because the probability value> 0.05.

3) Significance Test

From the results of SEM analysis the regression coefficients for each variable are shown as shown in figure 1 and table 2 below:

Table 2: Pathway Model Regression Coefficients

Causal Relations	Coefficient	P
KW ← CP	0,338	0,003
KW ← BIM	0,325	0,005
KB ← CP	0,303	0,007
KB ← KW	0,247	0,038
KB ← BIM	0,281	0,012

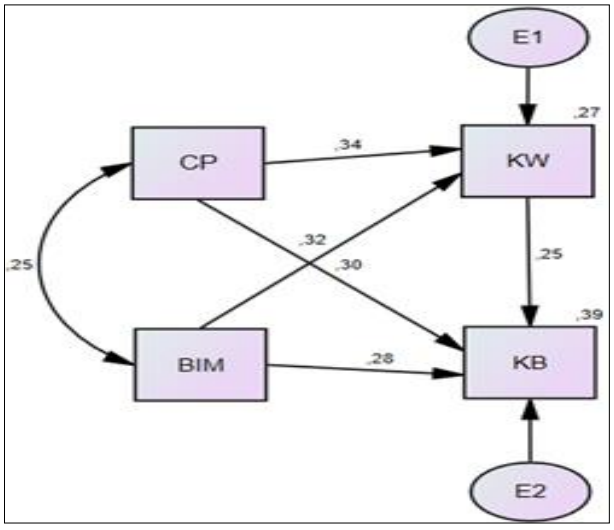


Fig. 1: Test of Significance.

The next step is to calculate the coefficient of determination from the final model which can be seen in table 3 below

Table 3: Final Pathway Model Determination Coefficient

Endogenous variable	R^2	Intercept
KW	27,4 %	3,510
KB	39,4 %	2,206

Equations based on regression coefficients and Intercept values for endogenous variables of the final model can be written as follows:

- KW = 3,510 + 0,338 CP + 0,325 BIM
- KB = 2.206 + 0.303 CP + 0.247 BIM + 0.281 KW

From table 3 Endogenous Variables Time Performance (KW) is significantly influenced by 2 variables, namely Crashing Program and BIM. The results of the study explained that Crashing Program and BIM had a simultaneous effect on Time Performance of 27.4% while 72.6% was the influence of other variables not examined.
Endogenous variable Cost Performance (KB) is also significantly affected by 3 variables, namely Crashing Program (CP), BIM and Time Performance (KW). The results of the study explain that the Crashing Program, BIM and Time Performance (KW) simultaneously influence the Cost Performance of 39.4% while 60.6% is the influence of other variables not examined.

4. Indirect influence

This study has 2 independent or exogenous variables namely Crashing Program (CP) and Building Information Modeling (BIM) and has 2 dependent or endogenous variables namely Time Performance (KW) and Cost Performance (KB). This causes direct and indirect influence. The amount of influence indirectly can be seen in Table 4 below

Table 4: Indirect Effects

	BIM	CP	KW
KW	,000	,000	,000
KB	,080	,083	,000

From table 4 it is known that Crashing Program (CP) and Building Information Modeling (BIM) have an indirect effect on Cost Performance (KB), where the influence of CP and BIM through Time Performance (KW) first. The magnitude of CP's indirect influence on family planning is 0.083, while BIM's effect on family planning is 0.080.

5. Integration of crashing program and building information modeling on performance

The next step is to see the great value of the integration of Crashing Program and Building Information Modelling on Performance. This can be seen in table 4 and figure 2 below:

Table 5: Integration of Crashing Program and Building Information Modeling on Performance

			Estimate
CP	<-->	BIM	,251
CP	<-->	K	,518
BIM	<-->	K	,502

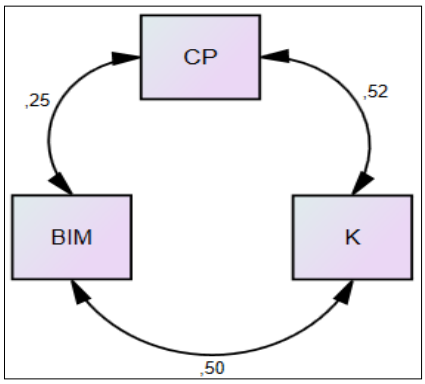


Fig. 2: Integration of Crashing Program (CP) and Building Information Modeling (BIM) on Performance (K).

From table 5, the value of the relationship or integration of Crashing Program (CP) and Building Information Modelling (BIM) on Performance (K) is positive and significant with values above 50%. So, if the company is able to implement Crashing Program (CP) and Building Information Modelling (BIM) simultaneously, the company's performance will increase by more than 50%.

6. Conclusions

Based on the results of data processing that has been done, it can be concluded as follows:

1) Crashing Program (CP) provides efficiency on time performance and cost performance by 52%
2) Builiding Information Modeling (BIM) provides efficiency on time performance and cost performance by 50%
3) Integration of Crashing Program (CP) and Building Information Modeling (BIM) provides efficiency for the implementation of the High Rise Building project by 25%.

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